

## **Assessing Human Impact on Coral Reef Ecosystems in Berau Regency, Indonesia: Implications for Conservation and Sustainable Tourism Development**

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### **Abstract**

This research explores the condition of coral reefs in Berau Regency, Indonesia, and the impact of human activities on these ecosystems. Coral reefs are considered crucial assets in supporting the well-being of local communities, especially in the context of tourism and fisheries resources. However, the increasing economic growth and human activities around coastal areas have pressured coral reefs, threatening their sustainability and preservation. This study employs a descriptive method utilising primary and secondary data and interviews with relevant stakeholders. The findings reveal that coral reefs in Berau Regency exhibit varied conditions, ranging from very good to poor. Threats to coral reefs include human activities such as unsustainable fishing practices, the use of explosives in fishing, and the development of tourism infrastructure. The research also underscores the importance of integrating environmental capacity into the development of Derawan Island as a coastal conservation tourism destination. Collaboration among the government, private sector, non-governmental organisations, and local communities is essential to maintain the sustainability of coral reef ecosystems while supporting the well-being of local communities.

**Keywords:** Coral Reefs, Berau Regency, Human Activities, Conservation, Tourism, Sustainability.

### **Introduction**

Coral reefs are precious coastal and marine ecosystems that offer significant potential for enhancing community well-being regarding economics, social interactions, and environmental sustainability (Moitra et al., 2023). The

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Coral Reef ecosystem is crucial in supporting people's livelihoods, particularly those in coastal communities (Cinner, 2014). It serves various essential functions, such as preventing erosion, stabilising sediment, providing shelter and breeding grounds for numerous fish species, serving as a source of raw materials for medicines and cosmetics, and functioning as an ecotourism attraction due to its limited presence in coastal areas. In addition to generating cash, tourism activities can stimulate economic growth in the local community by creating job and business prospects (Barbier et al., 2011).

Indonesia's coastal and marine areas are experiencing rising strain due to the rapid economic growth, including utilising coral reef ecosystems (Hadi et al., 2020). Consequently, some of these habitats are now facing threats. The species is commonly endangered due to various detrimental factors, including excessive fishing, coastal urbanisation, sediment accumulation, agricultural and logging pollution, tourism, climate change, and ocean acidification. The coastal ecosystem habitats in Indonesia, including mangrove forests, seagrass beds, estuaries, and coral reef ecosystems, have experienced physical harm (Nama et al., 2023). Coral reefs, found in coastal locations, are very susceptible to both internal and external disturbances. Coral reefs are facing a concerning drop in their existence, with significant damage leading to decreased quantity and quality. The degradation of coral reef ecosystems is intrinsically linked to human activities occurring on land and in coastal and marine environments (Madduppa et al., 2020).

The degradation of coral reefs will result in the loss of ecosystem functions and benefits, ultimately negatively impacting society, particularly local communities (Hoegh-Guldberg et al., 2019). Implementing management activities that allow coral reefs to function while ensuring sustainability and avoiding exceeding their carrying capacity, thus maintaining their long-term viability, is crucial. The ecological and economic consequences of damage are significant. In order to maintain a harmonious equilibrium between economic and ecological factors, it is imperative to implement sustainable management practices to safeguard the coast and sea. Managing coral reefs requires implementing multiple techniques, such as empowering coastal people, mitigating deterioration, and adopting ecosystem-based approaches that consider factors including potential, utilisation, and legal status (Zulkarnain et al., 2022). Management must accommodate the diverse interests of many stakeholders involved in coastal resource development, including the government, coastal communities, private sector/investors, and non-governmental organisations. Each entity has a vested interest in using natural resources in coastal regions.

The development and management of coastal areas is a collaborative effort of the government, corporate sector, and society to control, oversee, and cater to the needs of tourists through careful planning. Planning incorporates tourism development into a comprehensive programme that encompasses a specific location's economic, physical, and social development. Furthermore, effective planning should establish a policy framework that promotes and regulates tourism growth while ensuring the preservation of coral reef ecosystems. The rules and regulations on coral reef conservation in each District/City Regional Government are made and implemented based on their respective authority. It is necessary to conduct a study on this sector. The study's objective is to investigate the preservation of coral reefs as a tourist destination and the implementation of laws and regulations for the sustainable management of coastal areas. Regarding the topic of conservation policies and arrangements, coral reefs serve as an interconnected and sustainable coastal environment in the Berau Regency. They can be utilised as a policy tool for local governments to uphold conservation efforts effectively. Coral reefs: Each region will have specific changes based on its unique characteristics. Study findings provide valuable insights for local governments and tourist managers. Coral reefs play a significant role in the development of tourism. Coral reefs are a valuable reference point for policymakers when constructing sustainable and conservation-focused tourist locations. Coral reefs

### **Research Methods**

The research methodology employed is empirical juridical, utilising analytical descriptive research specifications. The data comprised primary and secondary sources, and the analysis used qualitative methodologies. The primary data was acquired through interviews with the Head of the Environmental Service, Fisheries Service, and the Head of Derawan Marine Village in Berau Regency. The research objects encompass several elements, such as data and information pertaining to regulations, tourism area development policies, coral reef conservation, sustainable coasts, legal materials, and other supporting data. These elements are mainly focused on the Berau Regency in East Kalimantan.

### **Results and Discussion**

Indonesia boasts a substantial number of 6 major islands and many smaller ones. Indonesia's ocean area surpasses its land area, with a total area of 7.81 million km<sup>2</sup>. This includes 2.01 million km<sup>2</sup> of land, 3.25 million km<sup>2</sup> of sea, and 2.55 million km<sup>2</sup> of Exclusive Economic Zones (EEZ). Indonesia is blessed with a rich coral reef ecosystem, which is a valuable natural resource. The

coral reef ecosystem in Indonesia spans an area of 7,500 km<sup>2</sup> within Indonesia's maritime waters and falls within the Indonesian Exclusive Economic Zone (ZEEI), which has a total area of 7.1 million km<sup>2</sup> (Supriatna, 2021).

Coral reefs are marine ecosystems located in tropical and subtropical waters, primarily composed of marine organisms that produce lime. Several species of calcareous algae and coral animals have a symbiotic relationship with other organisms residing on the ocean floor. Coral reefs have crucial functions in the ecological balance of coastal and marine environments, encompassing biology, ecology, and biota. Coral reefs serve as highly productive food sources for fisheries and essential habitats for spawning, egg-laying, and feeding for a wide range of economically valuable marine organisms. Coral reefs are physical barriers that break waves and protect coastlines from storm surges. Additionally, they possess significant aesthetic value, making them attractive for the growth of marine tourism (Noviana, 2019).

Coral reef ecosystems are primarily located in shallow water habitats, including continental shelves and clusters of islands in tropical waters. In order to attain optimal growth, coral reefs require transparent seas with elevated water temperatures, substantial wave activity, and efficient water circulation while also evading sedimentation processes. Coral reef ecosystems possess a solid capacity to regenerate damaged areas, provided that the habitat characteristics of different coral reef formations and the corresponding environmental conditions are appropriately preserved (Hermansyah & Febriani, 2020).

Coral reefs are marine animals that inhabit the ocean floor and consist of robust limestone rock (CaCO<sub>3</sub>) capable of withstanding the impact of oceanic waves. Meanwhile, the prevailing creatures in this area include coral animals with calcareous skeletons and algae, many of which also possess calcium carbonate. Regarding coral reefs, it is essential to differentiate between coral animals or corals (reef coral) as individual creatures or parts of a community and coral reefs (coral reefs) as a whole ecosystem (Suryanti & Indrawan, 2011).

Berau Regency boasts a wide range of coral reefs, covering an expansive area of 34,127 square kilometres. It is between 116° East Longitude to 119° East Longitude and 1° North Latitude to 2°33' South Latitude. Berau Regency is one of the ten districts/cities that fall under the jurisdiction of the East Kalimantan Province government. The overall area of Berau Regency is around 34,260.70 square kilometres, with a sea area of approximately 12,229.88 square kilometres, accounting for 35.7% of the total area. Berau Regency shares its western and northern borders with Bulungan Regency, located in the North Kalimantan Province. To the south, it is surrounded by East Kutai Regency, while to the east,

it is bounded by the Makassar Strait. The administrative area of the Berau Regency government encompasses 13 sub-districts, namely Tanjung Redeb District, Gunung Tabur District, Teluk Bayur District, Segah District, Kelay District, Sambaliung District, Derawan District, Maratua District, Tabalar District, Biatan District, Talisayan District, Batu Putih District, and Biduk-Biduk District (Mariyanto et al., 2015; Syafrie, 2016).

Due to its regional development and expansion, Berau Regency ranks as the fifth largest district, behind Kutai Kartanegara Regency. The Berau Regency is geographically divided into 13 sub-districts and 110 villages/sub-districts. It encompasses the mainland and minor islands, including the coastline areas. The main land is a constituent component of the mainland of Kalimantan Island, encompassing a coastline that spans 725 kilometres. The coastline land area measures approximately 787,773 hectares, while the water area spans 1,222,988 hectares. Berau Regency consists of a total of 52 tiny islands, which are distributed in both the northern and southern regions. In addition, there are various sandbars and atolls. The islands are distributed among four coastal sub-districts, including the Derawan and Maratua Island sub-districts in the north and the Batu Putih and Biduk-Biduk sub-districts in the south. Only four of the 52 islands are populated, specifically Derawan Island, Maratua, Kaniungan Besar, and Balikukup (Mariyanto et al., 2015).

The coral reefs in Berau Regency are extensively distributed across the islands and the region's northern and southern sea waters. The reefs in the northern region consist of many types of coral, including Mangkalasa, Masimbang, Buliulin, Pinaka, Tababinga, Lintang, Muaras, and Malalungun. Meanwhile, the coral reefs in the southern region consist of Karang Besar/Sapitan, Karang Dangalahan, and Karang Paninsinan. The coastal areas and small islands in Berau Regency contain three types of coral reefs: fringing reefs, barrier reefs, and atolls. Certain atolls have developed into islands, while others have transformed into saltwater lakes. The sole atolls present in the waters of Berau Regency are located in the northern region, specifically Kakaban Island, Maratua Island, and Gosong Muaras. Kakaban atoll is 19 square kilometres, Maratua Atoll is 690 square kilometres, and Muaras Atoll is 288 square kilometres. A survey conducted in 2003 assessed the diversity and condition of coral reefs, specifically focusing on hermatypic scleractinian hard corals in the region spanning from the north of the Derawan Islands to Sulaiman Bay in the south. The survey identified a total of 444 species of hard coral, with an additional 63 species that require further investigation. In Berau Regency, the coral reefs are characterised by the presence of various genera, including *Acropora*, *Montipora*, *Porites*, *Seriatopora*,

Pocillopora, Echinopora, Pachyseris, Millepora, Diploastrea, Favites, Galaxea, Stylopora, Pavoma, Symptyllia, and Cyphastrea (Syafrie, 2016).

The aquatic resources in Berau Regency possess diverse values and functions, including recreational value (marine tourism), production value (as a source of food and decoration), and conservation value (as a supporter of ecological processes and life support in coastal areas, and as a protector of beaches against abrasion threats). From an economic perspective, coral reef ecosystems are vital for the livelihoods of the surrounding coastal communities. Coral reefs serve as a barrier against sea.

Berau Regency in the Sulawesi Sea is renowned for its exceptional biodiversity, boasting abundant marine and terrestrial natural resources. Berau is a district within East Kalimantan Province that offers promising tourism opportunities on Derawan Island. Stunning views of sunrise, sunset, and underwater scenery characterise the island's natural panorama. The potential ecotourism products in the Derawan Islands include green turtles, coral reefs, manta fish, four species of jellyfish, various species of marine fish, adequate facilities, and cultural experiences.

The stakeholders in promoting community-led ecotourism development on Derawan Island include policymakers responsible for establishing regional laws and strategies, improving facilities, and promoting and educating the public. Additionally, the non-profit conservation organisation WWF plays a role in supporting conservation efforts. Furthermore, the tourism industry, including resort entrepreneurs and the local community, which are the leading managers and providers of permits for ecotourism development, are also involved (Mariyanto et al., 2015).

The parties involved in ecotourism development have specific tasks and responsibilities. The government, for instance, plays a crucial role in determining regional regulations. One way they do this is by establishing and issuing a Decree (SK) of the Regent of Berau No.660/151/BPLD-SET/2003, which focuses on monitoring and supervision. The government's approach to fostering ecotourism on Derawan Island involves safeguarding natural resource conservation (KSDA). This is achieved through the following strategy (Peta, 2019):

1. Conducting extensive promotional activities through various electronic media platforms such as websites, the internet, television, and radio, as well as utilising print media channels like brochures, newspapers, and magazines.
2. Constructing an airstrip to provide accessibility to Tanjung Redeb and Derawan Island.

3. Offering community training and establishing a tourism awareness group, known as “PODARWIS”, to augment the local community’s revenue.
4. Engaging with stakeholders to ensure the long-term sustainability of the environment through environmental preservation efforts.
5. Seeking solutions for managing landfill garbage on Derawan Island. The number is 6. Constructing tourism infrastructure on Derwan Island and its environs, including a tourist stage, dock, public restrooms, and waste receptacles.

The government’s responsibility in enhancing supporting amenities involves the development of infrastructure, specifically pavilions and recreational parks, which are now under construction. However, the allocation of cash towards infrastructure development does not align with the principle of ecotourism, which emphasises the preservation of natural surroundings without any alterations. The utilisation of spatial planning could be more suitable due to the construction site being situated within a sea turtle conservation zone, leading to disturbance of the turtle population. The government's efforts to promote Derawan Island tourism are widely regarded as successful and efficient, as evidenced by its use of various promotional channels such as websites, the internet, television, radio, print media, brochures, newspapers, and magazines. Engage in display activities and actively participate in national events. The government plays a significant role in socialising, primarily through the Tourism Awareness organisation (POKDARWIS). Nevertheless, the government needs to offer education and awareness regarding tourism’s positive impacts and advantages on local communities, resulting in specific local populations causing harm to the marine habitat. Hence, the government must have a more prominent role in facilitating education and disseminating information to ensure the sustained well-being of local communities (Peta, 2019).

Non-governmental organisations (NGOs), such as WWF, have a role and responsibility in protecting marine ecosystems on Derawan Island. However, the conservation efforts could be more effective due to the lack of support from local communities. This lack of support is primarily caused by the limited understanding and knowledge among the public regarding the advantages and benefits of natural resource conservation. The local community opposes the presence of the NGO WWF on Derawan Island because they believe that the biodiversity there directly benefits their well-being. In this instance, the government fails to consider the adverse effects of tourism development on Derawan Island, including constructing a tourism stage in turtle conservation sector B and establishing a recreation park in turtle conservation sector C. These actions are inappropriate and disregarded. Non-governmental organisations,

particularly WWF, need help preserving sea turtles on Derawan Island due to the government's abovementioned approach (Peta, 2019).

The tourism industry, particularly the private sector (tourism entrepreneurs), is crucial in supporting tourism on Derawan Island. This includes creating new job possibilities and providing employment for the local workforce. Additionally, the industry's positive influence extends beyond direct employment, as it contributes to the community's overall welfare through tourism development. Local communities play a crucial role as primary managers in developing ecotourism. They recognise the significance of tourism activities in enhancing their quality of life. However, not all communities on Derawan Island are engaged in ecotourism development due to a shortage of skilled and inventive human resources. There is no text provided. In order to enhance the well-being of the local community, the government actively engages in initiatives to incorporate the local community in tourist endeavours on Derawan Island. The government empowers local communities by conducting outreach programmes to promote using waste materials such as debris and broken shells in creating souvenirs. Additionally, the government supports the community by providing the necessary tools to assist in producing these souvenirs. Nevertheless, the general comprehension and awareness of its use still need to be improved, leading to the exploitation of turtle shells for the production of rings and bracelets, as well as the preservation of turtles and the extraction of shells from living specimens. Neighbourhood. Inadequate understanding and awareness of the socio-economic characteristics of the population, the state of the community's ecosystem in terms of the significance of coral reef preservation, and both internal and external factors affecting the management approach of different sectors in utilising coastal resources can lead to conflicts between economic interests of the community and conservation efforts. This can also hinder the identification of themes related to the conservation of coastal biological resources.

The marine conservation area in Berau Regency has been officially designated as the Coastal and Small Island Conservation Area of the Derawan Islands and Surrounding Waters in Berau Regency, East Kalimantan Province (KKP3K KDPS), according to the Decree of the Minister of Maritime Affairs and Fisheries of the Republic of Indonesia Number 87/Kepmen-KP/2016. The Conservation of Coastal Areas and Small Islands aims to safeguard and exploit these regions and their ecosystems, guaranteeing the continued presence, accessibility, and durability of their resources while simultaneously enhancing their quality, worth, and variety. As a party responsible for managing Derawan Island, the government confirms its compliance with the Berau Regent's Decree



(SK) No.660/151/BPLD-SET/2003, which pertains to the monitoring and supervision of natural resource conservation on the island (Mariyanto et al., 2015).

The condition of coral reef ecosystems can be directly impacted by the rise in interest in marine tourist activities, particularly in the absence of laws and visitor education at marine tourism sites. Tourist visitors can have a modest influence on coral reefs individually, but when considered collectively, they can exert pressure on coral reefs and affect the overall percentage of coral cover (Barker & Roberts, 2004). Marine ecotourism activities can directly and indirectly contribute to ecosystem harm (Dahuri, 2003). Direct impacts may result from physical contact with coral reefs, while indirect impacts can arise from constructing tourist facilities and infrastructure, such as hotels and docks. These developments can alter the functioning and utilisation of coastal and marine areas. The damage caused by human intervention, such as inexperienced divers standing on coral reefs, the use of trawl nets and bottom nets, the installation of traps in coral reef areas, and the use of coral as ballast and anchor for fishing boats, all contribute to the degradation of the environment. These practices, which are not considered environmentally friendly, significantly impact the management strategies implemented to protect coral reefs and meet the needs of human life. The human population poses a significant risk to the long-term viability of living coral cover, deceased coral, algae, and many coral reef ecosystems.

The coral reef ecology is highly susceptible to disturbances. Hence, coral reefs are highly susceptible to damage. By examining the coral reef condition map, one may observe the different categories of coral reef cover in various regions within the Berau Regency. This map reveals the broad range of coral reef cover conditions in Berau Regency, ranging from very good to poor. The coral reef cover in Berau Regency is predominantly strong, although there are variations in certain sections, ranging from good to moderate and bad.

Human activities such as fishing, mining, and construction are responsible for the damage inflicted upon coral reef ecosystems. Certain activities, such as fishing with explosives, can harm coral reefs. Most coral reef ecosystems are destroyed due to inadequate attention to various aspects of sustainability in their use and management. The deterioration of this condition is exacerbated by the contamination of seawater with substances such as potassium and domestic waste, as well as the exploitation of coral reefs as building foundations for fishing communities that utilise potassium. Coral reefs have suffered damage from using non-sustainable fishing equipment and the impact of solid waves. The coral deaths observed throughout the Karang Besar area are primarily caused by the increased pressure in the surrounding waters IUU fishing refers to fishing activities that violate laws, are not reported to authorities, and do not comply with regulations.

IUU fishing activity in the Berau Regency occurs when fishing vessels enter the area without reporting to the Berau Regency Fisheries Service or obtaining permission.

The surge in tourists visiting Derawan Island and the growing population in the area has prompted the development of lodging facilities, resorts, and homestays, resulting in increased structures. This, in turn, has affected the land's capacity to absorb rainwater. The prevalence of illegal fishing and the utilisation of explosive devices in fishing practices continues to be extensive. It significantly influences the state of coral reefs in the Derawan Islands' waters. According to data from RZWP3K Derawan Islands in 2014, the live hard coral reef (HCL) cover near Derawan Island experienced the most severe damage compared to other areas in the Derawan Islands region. There is a connection between the land's carrying capacity and the establishment of coastal conservation areas and small islands to promote tourism activities on Derawan Island. Examining the integration of Derawan Island's environmental carrying capacity is crucial for its development as a coastal conservation tourism destination in the Berau Regency.

### **Conclusion**

Managing coral reefs requires a sustainable approach involving the empowerment of coastal communities, damage mitigation, and the implementation of ecosystem-based approaches. However, in the context of Berau Regency, conservation policy implementation has challenges, especially concerning coordination among the government, private sector, non-governmental organisations, and local communities. Coral reefs in Berau Regency exhibit varying conditions, ranging from good to poor. Threats to coral reefs include human activities such as unsustainable fishing practices, the use of explosives in fishing, and the development of tourism infrastructure. Moreover, the increased tourism activities on Derawan Island have also impacted the environment, particularly in the construction of accommodation facilities and homestays. The increased number of such structures affects the land's capacity to absorb rainwater. Therefore, it is essential to integrate environmental capacity into the development of Derawan Island as a coastal conservation tourism destination in Berau Regency. In this regard, a collaborative approach among the government, private sector, non-governmental organisations, and local communities is crucial to maintaining the sustainability of coral reef ecosystems while supporting the local community's well-being.

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